

Spinal Reflexes

A reflex is an automatic, involuntary response to a nerve stimulus. Most reflexes are innate and represent the basic unit of motor activity.

Spinal reflex pathway

1. Receptor - conversion of a physical stimulus into an action potential;
2. the centripetal arm of the reflex – brings signals from peripheral receptors to the CNS, it is formed by cells of the spinal ganglion, their dendrites and axons;
3. reflex center – processes signals from peripheral receptors, usually represented by the spinal cord segment;
4. the centrifugal arm of the reflex – diverts the action potential to the effector, it is formed by motoneurons and their axons;
5. effector – muscle (striated skeletal, cardiac, smooth), myoepithelial cells of glands.

Division of reflexes

Division according to receptor placement:

- visceral
- organ receptors (visceroreceptors)
- reaction - contraction or relaxation of the smooth muscle of the organs, change in the activity of the glands
- viscerosomatic reflexes – reflexes that have a centrifugal arm in the somatic area, e.g. irritation of the receptors of the peritoneum during inflammation causes a reflex contraction of the muscles of the abdominal wall
- proprioceptive
- exteroceptive
- reaction to touch, pressure, pain, heat
- part of defense reactions
- Character of flexor and extensor reflexes - inhibition of the antagonistic muscle is part of it
- Distribution according to the number of synapses

Division of the reflex according to the number of synapses:

- monosynaptic
- polysynaptic

Monosynaptic reflex

Monosynaptic reflexes are the basic types of spinal motility.

Stretching reflex

This is the only true monosynaptic reflex. It can be summed up simply by the sentence: "If a muscle is passively stretched, it contracts." The receptor cell is the muscle spindle containing the intrafusal muscle fibers. Afferent ends on the α -motoneurons of the anterior spinal horns. Efferent leads to the motor plate. As a result, the excitations from the spindles have a facilitating effect on the motoneurons of the own muscle. When the muscle is shortened, the irritability of the spindles decreases.

Signals from the receptors are conducted by two types of fibers:

- strong fibers (phasic) - inform about the dynamic length of the muscle;
- thin fibers (tonic) - inform about the static length of the muscle.

Examples of reflex: patellar reflex, biceps reflex, triceps reflex, Achilles tendon reflex.

Gamma-system

Neurons of the gamma-system arise from the anterior spinal horns and their motor plates are located on intrafusal fibers. The gamma system is under the influence of the higher levels of the CNS, especially the reticular formation. By inducing contraction of intrafusal muscle fibers, γ -neurons modulate the sensitivity of muscle spindles and maintain their sensitivity throughout the length of the muscle. This system becomes especially important in postural reflexes.

Renshaw interneurons

These cells receive afferent from collaterals of α -motoneurons. It forms inhibitory synapses on the presynaptic motoneuron and in this way creates negative feedback control. If the activity of the motoneuron increases, the activity of recurrent inhibition will increase in direct proportion. In this way, interneurons balance changes in the level of motoneuron activity. The result of the action of the γ -motoneuron is inhibition of presynaptic neurons and disinhibition of antagonist motoneurons.

Polysynaptic reflex

These reflexes have one or more intermediate interneurons in their pathway.

Reverse stretch reflex

The receptor of the reverse stretch reflex is the Golgi tendon body, which is connected in series with extrafusal fibers. As a result of the involvement, the body is stimulated by contraction and passive stretching of the muscle. Afferentation ends with an excitatory synapse on an inhibitory interneuron, whose axon leads to an α -motoneuron of the anterior roots of the spinal cord. Efferentation ends at the motor plate of the extrafusal fibers of the same muscle. It follows from the connection that the activation of the Golgi tendon body dampens the activity of the motoneuron. At the same time, collateral leads from the rear corners, which prevent the muscles from being overloaded by an excitatory connection with the motoneurons of the antagonists.

Extensor reflex

Mechanoreceptors are stimulated by the action of a painless tactile stimulus. The consequence of this process is the contraction of the extensors and the relaxation of the flexors. In the spinal cord, there are multiple connections on interneurons.

By means of an inhibitory interneuron, the flexors are dampened.

The extensors are activated via the excitatory interneuron.

The extensor reflex is the basis of static postural reactions.

Flexor reflex (defensive)

The flexor reflex occurs in response to a painful stimulus. The impulse takes place afferently through A δ fibers of nociceptors and is connected to spinal interneurons.

- Excitatory interneuron of flexors → flexion of the irritated limb.
- Extensor inhibitory interneuron.

The location of the stimulus conditions the combination of movements. That is why we call the reflex plurisegmental (the resulting movement originates from several spinal cord segments) and at the same time pluripotent (the reflex overcomes any other movement).

Crossed extensor reflex

The cross extensor reflex is a combination of a defensive and a postural reflex. As a result of switching the flexor reflex through interneurons, the signal is transferred to the motoneurons of the opposite side, and at the same time the involvement of extensors and flexors is reversed. For that reason, during the flexor reflex of one side, the extensor reflex of the other side is involved. Such an arrangement is important for maintaining balance during the defensive reflex of the lower limbs.

Links

- DRUGA, Rastislav a Miloš GRIM. *Anatomie centrálního nervového systému*. 1. vydání. Praha : Galén; Karolinum, 2011. ISBN 978-80-246-1895-1.